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EVOLUTION.—*The mechanism of organic evolution.*[1] CHARLES B. DAVENPORT, Department of Genetics, Carnegie Institution of Washington. (Communicated by W. J. HUMPHREYS).

As we look over the world today we see, as the ancients did, the marvellous phenomenon of a world populated not only by humans but also by many hundred thousand so-called species of animals and plants existing in uncountable individuals whose number can no more be expressed by the ordinary system of numbering than astronomical distances can be readily expressed in miles. A cubic millimeter of the blood of a leucaemic mouse may contain over a million white corpuscles; and there may well be 1,000 such cubic millimeters of blood in a mouse. This gives us a billion white corpuscles in one mouse, not to consider the other cells of the mouse's body. These white corpuscles are essentially organisms, with powers of food-gathering, assimilation, excretion, locomotion, sensation, etc. And this is but one mouse. Even if we assume so few as 2½ house mice to a human being on the earth (and mice are ubiquitous) we shall have 5 billion billion white blood corpuscles in house mice alone. But probably the pathologist might have as many bacteria in *one* of his test-tubes.

I have sometimes speculated on the number of organisms visible to the low power of the microscope that are in our Inner Harbor at the end of August, when it has a creamy, soup-like consistency. Assuming 1 per cubic millimeter, which is certainly far too small, there would be a quadrillion individuals in this space which would occupy only a square millimeter in the one-millionth map of the world, which has over half a billion square millimeters.

[1] Presented before the 233rd meeting of the Academy, as one of the series of papers on Origin and Evolution. Received for publication April 28, 1930.

Pardon me for wearying you with figures. I have wanted to put you in a position to grant my first point that the number of individual organisms on the globe is essentially infinite, though the number of kinds that naturalists have been able to count and describe in the past 150 years is still finite.

Next, I would call to your attention that most of these individuals have a short life and are quickly replaced by others, even if we leave out of account the unicellular organisms which retain their individuality only for the few hours or minutes necessary to reorganize and divide again. Even if we assume that the average length of life of an individual is a year—and it is probably not over a day—then we have to consider the remarkable phenomenon of an annual wiping off of the slate, as it were, of this infinitude of individuals each year and their re-formation the next year. This is possible owing to the immense reproductive capacity of certain species. Thus one oyster may lay 50,000,000 eggs during a few days in the summer and one sea urchin 20,000,000 eggs. These are samples, merely, of reproductive capacity of individuals. Perhaps now we have gained some conception of the number of individuals that have been produced each year on the earth, during we do not know how many millions of years.

If now you are willing to admit that the problem of organic evolution is that of the evolution of an organic mass consisting of an infinitude of individuals reproduced during an infinitude of generations, that may serve as a starting point to our inquiry as to the mechanism of organic evolution. Thank you!

Now, each individual has a certain recognizable form and acquires it through a certain course of development, be it more or less complex. The center of control of this form is largely, if not chiefly, in the chromosomes of the organic cells,—in its genes, to be more precise. In fact the soma of organisms, what we see, is just an index of the form-producing and maintaining factors of the genes—always, of course, recognizing that the end result is a sort of reaction between gene and environment. Now if the world of organisms is composed of an infinitude of kinds it is because the germ plasm is of an infinitude of kinds. The course of organic evolution has been, and is, what it is because the germ plasm has undergone and is undergong the changes that it has undergone and is undergoing. This change of the germ plasm is called mutation. Mutation is one of the great factors in organic evolution.

Now what do we know about mutation? First, we know that it is wide-spread. This knowledge has first become precise, as organisms have been studied in successive generations, under controlled conditions.

Such mutations have long been known among domesticated organisms like potatoes, poultry, guinea pigs and dogs. Mutations have been so long known among domesticated organisms that it was natural for Darwin to discuss "Variation under Domestication" and for him and others to consider what quality of domestication it is that induces mutation. During the past 25 years in several species of animals taken from the wild, many generations have been followed. And in consequence we now know that mutation has not necessary relations to domestication; but only that domestication enables us to see and perhaps preserve such mutations. Rather, I should say, the product of such mutation, for the mutation has occurred in the germ plasm before it has become visible in the soma of the organism that develops under the control of the mutated germ plasm.

Let us now consider some of the facts of mutation that experimental study has revealed.

First, mutation is probably universally occurring in all germ plasms. Thus, in various mammals that have been reared so that they can be observed, mutation has occurred in all visible parts, in internal organs, and in resistance to disease. In man, which, is the mammal that has been most thoroughly studied, we have mutations in hairiness, pigmentation, skin growths, appendages and digits, teeth, sense organs, form of internal organs, like the iliocecal valve, size and functioning of the endocrines, structure and functioning of the nervous system, of the blood and of the reproductive system. Finally, we have mutations in disease-resistance, due to obscurer morphological or bio-chemical idiosyncrasies.

Among pigeons, mutations in color, form of beak, nervous behavior have arisen in the Whitman-Riddle series. In poultry, I have in the course of 10 years got apparently new mutations in toes, wings and nervous reactions. And any poultry fancier knows of the mutations that have occurred in the past 75 years in color and pattern, in comb, in cerebral hernia and crest, in feet, wings and beak, and in egg-laying capacity.

In the insects which have been bred for rapidity of generations mutation has been repeatedly found. In *Drosophila*, Muller computes that among 500 factors in the X-chromosome of *Drosophila* each, in the average, mutates at the rate of 1 mutation in 4 years. This would seem to mean that, if you followed a single chromosome and when it divided considered one of the daughter chromosomes and so proceeded through the generations, then at the end of 4 years the

expectation is that in this line of chromosomes some one gene will have mutated and at the end of 4 more years that gene, or some other in the chromosome line we are following, will have mutated again. But there is an infinitude of chromosomes in the totality of all *Drosophila melanogasters*. The number in a single gonad is vast; the number of gonads in the world of Drosophilas that swarm in the autumn over every mass of decaying fruit in a million of orchards as elsewhere is practically infinite. One sees that just *Drosophila melanogaster* is producing an infinitude of mutations each season, and it has been producing this infinitude annually for a long time; but time does not count for much, for infinity times a finite number remains infinity. *Drosophila* throws upon the world each year, a vast number of kinds of mutations in inconceivably great numbers.*

And *Drosophila* is not exceptional. Let us take a small water crustacean, one of the Daphnids. Banta has reared lines of these in captivity and examined the progeny daily. In one line of *Moina macrocopa*, carried parthenogenetically, a dominant mutation has occurred, on the average, at least once in 50 generations, but many more recessive mutations have occurred and been phaenotypically unexpressed. Now the number of Daphnids, which crowd any suitable pond in both hemispheres during each spring and autumn, is beyond conception. For a single circular pond a hundred feet in diameter may well contain during the season many million Daphnids, if 1 is allowed to the cubic centimeter. The total of mutations that occur in one year in *Moina macrocopa* must be inconceivably great.

Certain of the lower forms are mutating even more strikingly. At least such would seem to be the case if the remarkable variations shown by Leonian in the fungus, *Fusarium*, may be regarded (as seems most probable) as mutations. Here scores of strains arise, in but a few years, even in a uniform culture medium, and perpetuate themselves. The strains vary in their rate of growth, pigment formation, type of fruiting, kind of spores, and reactions toward temperature, acids, dyes, and toxic substances. Apparently such mutation is going on all the time in nature.

As we consider these best known cases of mutation and realize that all of the countless chromosomes and genes are undergoing occasional change we are appalled by the universality of mutation and are caused to wonder how any species remains constant in nature to the extent that it is possible for a second naturalist, 50 years later, to identify in nature the species already described; we are less surprised that the

reviser of a genus a generation or two later will find twice as many species as his predecessor. We gain a lot of sympathy for the much abused species-splitter who, observing nature without the restriction of tradition, finds vastly more species than had been previously described by his predecessors. [Slides of variations in feral species (species-groups) were shown. These are probably cases of mutations that have established or may establish biotypes or incipient species.]

Organisms seem to be producing mutations at an inconceivably rapid rate, in infinite quantity. The wonder is that there are such things as species. One is led to inquire if, in describing species, taxonomists are not merely inventing transient, evanescent categories.

Such a conclusion is unjustified. Every taxonomist will tell you that the things he describes and others have described before him are real entities. If I am studying thrips and wish to secure a species described 50 years ago as living in a certain composite plant in eastern Russia, then if I go to the designated locality and look in the designated species of flower I will find the species with all the characters described 50 or 100 thrips generations ago. How is such an experience in constancy to be harmonized with universal mutation? This is perhaps the heart of the problem of evolution.

In considering the fixity of some species it must first of all be recognized that a species is a complex of morphological and physiological characters that can not exist alone but is absolutely dependent upon the external world for its existence. The organism must live in a medium of such and such physical qualities, at such a temperature, in the midst of such radiant energy, with access to such and such food stuffs which it is capable of taking in and utilizing for its metabolism. Every organism is extraordinarily closely fitted to its environment. And that environment may be very complex.

I will illustrate this principle by reference to the almost microscopic Collembola that live on the beach at Cold Spring Harbor (Fig. 1). They live in an area of apparently washed sand and pebbles in a region that is covered twice a day several feet deep by sea water and then exposed to the air, in a region swept by strong winds, overlaid by ice in winter, and exposed to the hot sun's rays in summer (Fig. 2). A region where the sandy substratum is caused to shift by the action of waves, and its pebbles to roll. The region looks unpropitious for any organism, yet of one species of Collembola in an area a kilometer long and 5 to 8 meters broad there are probably in the middle of summer a hundred million individuals. And they are meeting successfully the

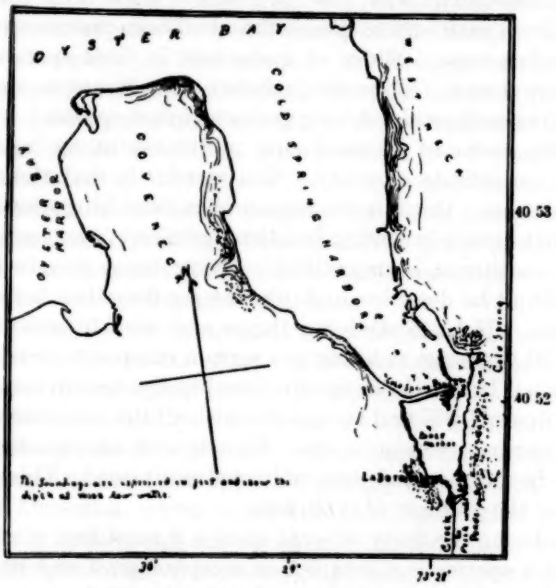

Fig. 1.—Map of Cold Spring Harbor, showing spit (Cold Spring Beach)

Fig. 2.—Photograph of north side of sand spit, near the western end, at low tide. In the central foreground is the high tide line, marked by a mass of débris. On the left is the gravelly lower beach; the middle beach and storm bluff are at the right.

difficult and complex conditions imposed by that particular habitat. If the habitat be compared to a most intricate lock, the organism is a most intricate key that fits that lock completely. How has this key come to fit this lock?

First of all, it is to be said that the Collembola in question is the only larger organism that is found in any huge numbers on and in the great portion of the beach. Worms there are that live in the sand of the beach; crustacea and insects there are that feed on the débris that

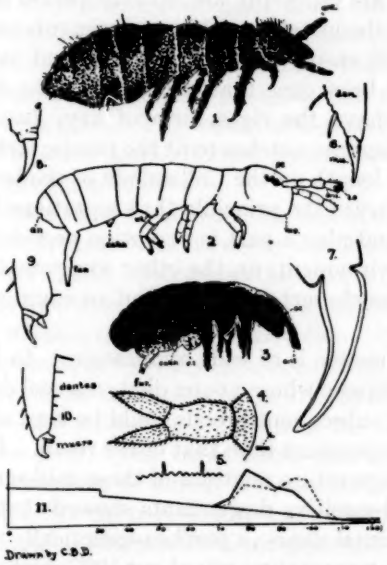

Fig. 3.—Drawings of 3 species of Collembola on the beach, (1), (2), and (3), with some details of their structure. (11) shows the relative frequency of *Isotoma* on the beach; the abscissae represent distances from the beach line on top of the beach; the ordinates, the proportional frequency of occurrence.

is thrown up by the sea at the high tide line; but it is only the Collembola that swarms over the beach (fig. 3).

Why are the Collembola the only organisms that make such use of the beach? The answer seems to be that they are the only group that holds a key approximating the needs of the beach lock. Two other species of Collembola live on the edge of the beach, in relatively small numbers. But one, *Isotoma berselsii*, has the combination of small size, slender form and greater capacity for jumping that are demanded for successful life on the beach. Another species which has a chunkier

form and is less successful as a jumper is found on the beach but is much less numerous than the first. Now the Podurid Collembola have, in general, a structure and reactions that lead them to live in situations not so very different from those occupied by *Isotoma*. They are found on water or in humid earth or in moist caves, or in crevices of moist walls. If anything is to survive in the sand of the sea beach it must come out of a group with instincts and structure that make it possible and preferable to live in such places. However, the interstices of the sand of the beach are especially fine and the period of exposure to the air is so brief that the insect must have movements and responsiveness of such sort as will ensure adequate exercise and oxygenation of the tissues during the brief time that it is exposed to the air. Collembola, in general, have the right form of key; *Isotoma berselsii* has precisely the appropriate notches to fit the precise lock of the beach.

I have dwelt at length on the Collembola of the beach because they may serve to illustrate the principle that mutations become the characters of species and play a part in evolution *provided* they meet some demand of the environment; or, the other way round, a new mutation persists as a species character if it can find an environment to which it is suited.

This general principle is of wide application. In Banta's daphnids there appeared a female whose young died on a cool day in the autumn. It was found that subsequent broods could be kept alive in an incubator at a higher temperature than that of the room. In short, an investigation of the temperature relations of these cold-sensitive young and their equally cold-sensitive descendants showed that there had arisen by mutation a thermal clone—a parthenogenetically reproducing strain—whose optimum temperature was about 10°C. higher than that of the ordinary daphnids. This mutation was fatal at the ordinary room temperature; it had important survival value for the environment of an incubator; it would have had an important evolutionary value had there been a warm spring near by into which the strain could have been transplanted. This experience, indeed, shows the probable method by which aquatic animals have come to inhabit hot springs. It is not by gradual change wrought on the germ plasm by the direct action of the high temperature of the water, but rather the fine opportunity for survival afforded by the high temperature to any chance thermal mutant.

Again, as has long been known, many of the animals that live in caves are blind and much speculation has been offered to account for this blindness. The old idea was that, through disuse and the parsi-

mony of nature that would prevent it from continuing to form useless organs, the useless organs were no longer formed. On the other hand, Eigenmann, through his extensive knowledge of fishes, was able to point out that the blind fish of caves belonged to just one family of fishes, a family that had mutated in the direction of blindness in various parts of the continent. Now, some of these mutations in the direction of blindness have survived even where there are no caves, but where there are waters running through densely wooded swamps and characterized by dark holes where poor sight is no handicap to the fish. When a blind mutation arose in that family of fishes living in the region of limestone caves of Indiana and Kentucky, that mutation was no handicap to its possessor. For the possessor had other sense organs sufficient to secure its prey. The waters of the cave, indeed, removed competition; and in other ways afforded an extraordinarily favorable environment for this genus of fish.

Another illustration may be afforded by still another group of animals. As you know there are vast numbers of molluscs living in the sea and in fresh waters; clams, oysters, periwinkles, cuttle fishes, squids are familiar marine molluscs. But there is a group of molluscs that has a history quite as striking as that of the cave fish. This group lives on the land, and sometimes, in very dry situations, even semi-deserts. In this situation the molluscs breathe by lungs instead of gills. How have the land molluscs—the pulmonates, including the snails and slugs—come to live on the land? One explanation that has been offered is that some marine ancestors gradually moved into streams and higher up into ponds which dry up periodically and there became gradually modified to breathe air. The matter is not quite so simple. The river mussels live in streams and ponds that occasionally go dry; they perish under these circumstances by the million; and yet they have never become adapted to land life—the appropriate mutations have never been afforded. Our land snails are the end result of a long series of mutations that have permitted life on the land. The first mutations in this direction occurred in certain marine snails with a gill chamber whose opening is so small that it can readily be closed to prevent the ingress or egress of water. Any mutation in this direction would enable its possessor to enter into the between-tides zone.

Actually, there live on our shores shore snails, belonging to the family of Littorinidae inhabiting a level where they are exposed to air for 12 to 20 hours of the day. Indeed, among the Littorinas one finds species that differ greatly in their emancipation from the sea. During

the recession of the tides the Littorina keeps the opening to its mantle chamber closed; so its gills are held in a medium of saturated air (fig. 4).

Now, it is out of this general group to which the Littorinas belong that the land snails have arisen. Any continued mutation in the direction of gill reduction or enclosure of the mantle cavity would have been in the direction that would have permitted the possessor to pass to dryer parts of the shore line and, incidentally, to escape from its enemies. The point is that not just any group of marine snails was able to adjust itself to land life, but only a group in which favorable mutations arose. The land crabs and the lung fishes represent the end stages of a similar evolutionary history to that of the land snails.

While it appears from these considerations probable that adjustment to extreme conditions of life has been rendered possible by favorable mutations, it still remains to consider what light modern genetical studies throw upon the details of this process.

Fig. 4.—*Littorina litorea.*

We have seen that reproduction is unlimited and that mutation is constantly occurring; not to be sure in infinite amount in all directions equally but abundantly in certain genes; more rarely in others. We have now to consider in turn what induces mutations; what gives direction to mutations; how are the adaptations in nature brought about?

First, the causes of mutation are clearly determined, in part, by the unstable nature of the gene itself. The genes are very complex molecules, or rather groups of molecules. Now, many complex molecules are known in chemistry that are so labile that they break down almost spontaneously. How many compounds have to be kept in the dark, at a low temperature, undisturbed in order that they may "keep" at all. In time they "spoil", even under the best of conditions. The rate of change may be accelerated by heat, light and irradiation. The genes are not exceptions to the rule of change in labile substances. While the nature of the process of mutation in the genes has shown itself little influenced by external agents the velocity of spontaneous change is readily altered. Thus Muller, Hanson and others find the speed of mutation accelerated by increase of temperature, and by X-rays. No new mutations have been brought forth by the X-rays, but mutation occurs more rapidly. The X-rays do not direct evolution,

or even mutation, qualitatively, but afford opportunity for more rapid evolution by providing, in larger amount, one of the factors—mutation—necessary to evolution.

The fact that X-rays may accelerate the process of gene mutation has led some to the conclusion that all mutation is due to radiations. No doubt conditions compatible with the life of the soma *may* be found that will not permit of mutation, but it does not seem probable that this will ever be the case. Just the conditions essential to life probably provide the conditions for gene mutation.

Second, what gives direction to mutations? It is obvious that the organic world is far from being the infinitely diverse collection of haphazard and meaningless variants that we might expect were mutation entirely uncontrolled. It seems probable that, under ordinary conditions, genes break down or disintegrate in orderly fashion dependent on the nature of the gene. An illustration, which may be more than a mere illustration, is afforded in the rare earths where uranium breaks down into radium and radium into lead. Each stage, in turn, is determined by the immediately preceding stage.

So, in organisms, the mutations are usually of a recessive nature, which seems generally to imply that they are produced by a loss of something from the parental gene. In the different species of one genus the same kind of mutations occur. Thus between *Drosophila melanogaster*, *D. simulans* and *D. virilis* quite parallel mutations occur and are identified in many cases with genes occupying comparable loci in the chromosomes. Among mammals with which we are naturally best acquainted certain mutations occur again and again. Thus albinism, coat-color-pattern, hairlessness, elongated hair, reversed hair, taillessness, abnormal hands and feet, particularly digits, horns or hornlessness, achondroplasia. The recurrence of these mutations in various species of mammals, as tabulated by Osborn (1912), indicates that mutations are far from haphazard in origin, but probably depend upon the same genes with the same structure and capacity for change.

Finally, the mutations with which we are familiar constitute only a fraction of those that occur. Every student of intra-uterine stages of mammalian development is familiar with the phenomenon of intra-uterine deaths. So far as our observations go, it appears that in mammals more young die *in utero* than are born. Every student of development of sea urchins and other marine organisms knows that a large proportion of those that start to develop do not proceed far. We

see that early developmental stages are those in which great selection takes place; probably because the embryos carry non-viable mutations. From this point of view the individuals that reach maturity constitute the fraction that have undergone no *lethal* mutation.

The fact of lethal mutations (for they have been demonstrated in many cases) helps us to understand the other fact that in the midst of the world of mutations the organisms that come through are more or less well fitted to survive; they are not always the best, but they are good enough to pass the censorship of environment.

And this brings us to a consideration of the phenomenon which Darwin stressed, namely, of adaptation to environment. We have already seen that such adaptation is partly brought about through the selection by the organism of an *environment* that is adapted to it. We may now consider the case of selection by the environment of *organisms* that are adapted to it. In general, the organism must be able to play properly its part in the flow, in and out, of the chemical agents, water and food stuffs, upon which its life and activity depend. It must be capable of meeting emergencies of climate and organic enemies. It must pass the censor at every stage or be squelched.

A little experience of my own, on which I published some years ago, will serve to show how strict is this censor. I reared a large number of chickens to the one pound stage and had about 300 running over a grassy plot on about the tenth of May, at a time when crows are feeding their nestlings and hunting especially meat for them. About 40 per cent of the birds had a white plumage, 40 per cent a black (or nearly black) plumage and 20 per cent a plumage in pencilled, or striped markings, more or less like that of the ordinary game, or the jungle fowl. Of these the crows killed 24. Expectation, on the basis of random attack on the birds, was that about 9.6 would be white, 9.6 black and 5 pencilled. Actually there were killed ten white, thirteen black or prevailingly so, and one coarsely mottled gray and buff. No truly pencilled bird was killed. This observation tends to illustrate the principle that the self-colors in wild birds tend to be eliminated because conspicuous to their enemies; birds with mixed pattern are relatively immune from attack because relatively inconspicuous.

Now, though it has not been experimentally proven, yet the hypothesis may be entertained, that the presence of light colored mice in limestone regions and of dark colored mice on lava beds may result from an elimination of mutations that are in disharmony with the background. To nocturnal predaceous animals, like the owls which catch

mice, a white or light yellow mouse on a black lava bed would be seen and captured before a black one.

One further fact must be taken into account in considering the adjustment of organisms to their environment, and that is that change of environment may well cause, and apparently has in the past often caused, the elimination of species over the whole extent of their area of destruction.

Consider how wide-spread must have been the consequences on the fauna of the northern hemisphere as far south as Long Island and even further south of the great ice sheets that covered the circumpolar territory in glacial epochs. Many poorly clad species of mammals must have found the icy conditions insupportable; just as the mastodon and mammoth did. The change in environment may be of a more subtle sort. Thus the great size and herd instincts of the bison enabled it to develop enormously on the extensive plains of North America and rendered it more than a match for the Amerinds living in a stone age. Just this size and number wholly unfitted these mammals for the new environment of the agressive, agriculturally inclined white man, armed with a rifle. Agriculture and free-ranging bisons could not coexist and the rifle eliminated the mammals. So today the great size and aggressiveness of the large mammals of Africa are a challenge to the sportsman and the future seems to spell extinction for them. Here we have to do with elimination resulting from what may be called a cultural evolutionary "mutation"—the rifle.

But man's part in evolution is not merely in the elimination of his large enemies, which he has all too thoroughly mastered, but in his struggle with the small and innumerable insects that threaten his agriculture as it becomes more intense. The more successful and prolific an insect injurious to agriculture is the more certainly will it arouse man's destructive energies and the greater the certainty that the all too favorable mutation that is the cause of its success will be the cause of its elimination in whole, or part.

But mutations of a still more dangerous sort are threatening mankind—mutations in the world of organisms that live as parasites on the human protoplasm. With the more conspicuous of these parasites, external and internal, man has learned to cope. One by one the pathogenic bacterial diseases are being eliminated or reduced in frequency. But now we face still smaller parasitic particles—the filterable viruses—which are, at present, practically inaccessible to man. There seems to be reason to conclude that they are mutating, also, and

perhaps rapidly. The waves of influenza epidemics that pass round the world in periodic fashion assume slightly different aspects—show somewhat different symptoms—in successive visits. Those who are resistant to the one visitation may show slight resistance to the next. The selections of the past have left the stocks of the more crowded continental areas a hardy resistant people—far more so than the peoples of distant oceanic islands that had not undergone selection for resistance to the ultra-microscopic parasites. When one contemplates the high mortality of the influenza epidemic of 1918 one realizes that notwithstanding this high resistance it is quite within the range of possibility that at some future time a mutation shall arise in these viruses such that no human protoplasm is protected against it or can protect itself against it. Then our boasted skyscrapers might become inhabited by bats and the safe deposit vaults of our cities become the caves of wild animals.

Whether or not this will occur in the future, the possibility brings home a realization of the fact that man is not merely looking on the process of evolution taking place around him but, as an organism, he is a part of that evolution; he is acting upon other organisms and being acted upon by them as well as by the inorganic world in which he lives. He is attempting a mastery of that world; and, indeed, upon such mastery his fate may depend. His ability to master that world depends upon his superior gifts of intelligence to see relations and to idealize new ones. How much farther man can go in this direction depends upon the capacity for development of the intelligence. There are those who warn us that we are approaching the limit and must sometime in the future wait for further human evolution to make further fundamental progress. To wait until nature affords the desired mutation may mean indefinite postponement. Can not man himself control his evolution? Two methods are open; one the production of new and better combinations of traits by appropriate matings. This is the method of the applied geneticist interested in creating new and improved varieties. This is the method that is open to man also, if only some change in the social order may make it feasible to apply our knowledge to the improvement of the genetical combinations in mankind.

But still another way may be opened in the future; that is the acceleration of mutation by irradiation. The method is fraught with tremendous difficulties. The commonest effect of irradiation of the gonads is the production of defective, often happily non-viable individ-

uals. Whether the production of scores of defective strains to secure one line with a superior mutation is justified will have to be considered. But if man is to evolve he must not decline to use nature's tools of mutation, cross-mating, selective elimination while he seeks to become fitted to meet the requirements of an ever changing and ever more-demanding environment.

To sum up, then, the mechanism of organic evolution, as I see it, consists of the following processes:—

1. Infinite capacity of the germinal material for reproduction.
2. Infinite capacity for mutation.
3. An infinitude of kinds of environments.
4. Extensive opportunities for dissemination of the mutant individuals over earth, permitting some of them to find an environment for which they are especially fitted.
5. As for the rest of the infinitude of individuals, non-mutant and mutant (beyond the number required for replacement) *elimination.*

In a sentence, nature's mechanism of evolution includes the elements of: an infinitude of kinds of environments, infinite reproduction, infinite mutation, infinite opportunity for new mutants to find appropriate environments and elimination of all of the infinitude of other individuals that are not required for replacement.

Homo sapiens is only a natural species with a highly evolved hand and brain. This species has reached its lofty position in evolution by the processes described. It is proud of its control of nature in certain directions. Let it beware lest it think it can evolve further by a man-made formula that may suit its perverted desires but must eventually fail of permanent progress if opposed to the formula of nature.

PALEONTOLOGY.—*Remarks on Dr. George G. Simpson's work on the Pleistocene paleonotology of Florida.*[1] OLIVER P. HAY, Washington, D. C.

Recently Dr. George G. Simpson, of the American Museum of Natural History, New York, has published a number of papers on the Pleistocene paleontology of Florida. They are important communications, and with the activity of this author and others now interested in this subject the paleontology of Florida must soon become much better understood. It is with regret that I must present some criti-

[1] Received May 12, 1930.

cisms on Dr. Simpson's conclusions. I shall be concerned especially with his paper entitled: The extinct land mammals of Florida,[2] and with another having the title: Pleistocene mammalian fauna of the Seminole Field, Pinellas County, Florida.[3]

In this latter paper Dr. Simpson discusses the correlation of he Pleistocene deposits; and he credits the present writer with having expressed the most definite opinions on the subject. He states that these opinions seem largely to rest on three assumptions, of which the following is the first: That each local fauna studied is actually an assemblage of contemporaneous mammals.

Dr. Simpson[4] says that this is illustrated in the case of the so-called Peace Creek fauna, "elements of which were largely derived from both Pleistocene and older deposits." My list of the mammals collected near Arcadia is found on page 381 of Publication No. 322 of the Carnegie Institution of Washington. Of that list of 15 mammals there is, I believe, only one, *Hipparion ingenuum*, whose Pleistocene age can be fairly questioned; and that this *Hipparion* may have continued on even into the Aftonian is again suggested by the recent discovery by Simpson[5] of the "three apparently Pliocene species *Hipparion ingenuum*, *H. plicatile*, and *Serridentinus* sp.," along Itchatucknee River, Florida, associated with Pleistocene fossils.

Dr. Simpson recalls also my reference[6] of the fossils of the Alachua clays to the Nebraskan stage. In this case there are involved *Gomphotherium floridanum*, *Procamelus*, two species of rhinoceroses, *Hipparion*, and *Parahippus*. Dr. Simpson declares these genera are certainly not younger than Middle Pliocene. Now I am willing to admit that I was probably wrong in this assignment; but for this action I gave my reasons; and, whatever the probabilities, nobody ought to express himself as certain that these genera, or some of them, did not continue on into the first glacial stage, where I put them. The Pleistocene climate of Florida has been inordinately extolled and it was probably as "congenial" during the last half of the Pliocene as it was later, or more so.

I am further supposed[7] to have nurtured the assumption that the Pleistocene mammalian sequence is certainly known, if only in part,

[2] State Geol. Survey, 20th Ann. Rept. **1929**: 229–279.
[3] Bull. Amer. Mus. Nat. Hist. **56**: 561–599. 1929.
[4] Bull. Amer. Mus. Nat. Hist. **56**: 569. 1929.
[5] Amer. Mus. Novitates **406**: 13. 1929.
[6] Carnegie Inst. Wash. Publ. **322**: 375–378.
[7] Bull. Amer. Mus. Nat. Hist. **56**: 568. 1929.

for other regions of North America, and "especially along the margins of the drift." This assumption Dr. Simpson grants is partially justified; and then he follows with a sequence that I wholly repudiate, —one which I have never before heard expressed. The first phase is said to embrace the time from the earliest Pleistocene to just before the close of the epoch. During this phase *Hipparion* was absent, "*Equus* occurred, tapirs and camels were present, and most of the smaller animals and all of the larger ones were of now extinct species."

Now, there was no such natural phase or stage of evolution or extinction. There was no known time in the Pleistocene, at least after the Nebraskan, when most of the smaller animals and all of the larger ones belonged to now extinct species. According to Simpson, some of the ground sloths and peccaries continued on into his second phase, and certainly he might have mentioned many other mammals. This phase was partly late Pleistocene, partly "post-glacial," which is Recent. What important biological or geological events happened to distinguish this phase from the first; and what occasion is there for recognizing a third phase which does not belong to the Pleistocene? And what authority has he for saying that no elephant, no mastodon, no tapir, no peccary, no ground sloth lived on into the Recent?

Cope is credited with contributing to this history of paleontology. Cope and Marsh and Dall instinctively avoided such an allocation of the faunas of the Plains, of Texas, and of Florida, and put them in the Pliocene, until G. K. Gilbert convinced them of their error. It was left for a younger generation to rush to the other extreme and to accept the doctrine that any Pleistocene animal may be found at any stage of the Pleistocene and in any locality.

Dr. Simpson's first phase occupied some 400,000 years and glided into his second and third phases without having ushered in any critical event.

I regard it as incontestable that any adequate assemblage of Pleistocene fossils collected anywhere outside of the glaciated regions, west or south, will contain a much higher percentage of extinct species and genera than will be found in any deposit overlying any drift after the Nebraskan. During the Kansan glacial stage is probably where a paleontological break occurs. The pre-Kansan fauna, varying somewhat with latitude, longitude, elevation and climate, embracing ground sloths, glyptodonts, megatheres, numbers of horses, camels, *Elephas imperator*, *E. columbi*, and *Stegomastodon*, extends from the Atlantic to the Pacific and from the Gulf to the south border of the

drift. As long as geologists, paleontologists and anthropologists stand on glaciated lands they are held down to definite periods of time, but once outside the drift deposits they feel free to refer any long-ago extinct animal to a time within a few hundred years, especially if its presence menaces the theory of the late appearance of man.

Dr. Simpson adds that it is especially along the margins of the drift that I believe that the mammalian sequence is known.[8] Quite the contrary. The drift sheets and the drift margins simply conceal the ancient fauna, the Aftonian, from view. In deposits lying on the Kansan drift, and Illinoian drift and the Wisconsin, from Cape Cod to the Rocky Mountains, are found the extinct members of the late fauna. In these deposits occur *Mylodon*, *Megalonyx*, *Canis*, bears, the American mastodon in abundance, *Elephas boreus* in abundance, one or two horses only, a few bison, peccaries, and possibly any species now living in the glaciated region; but so far as yet discovered, no megathere, no *Nothrotherium*, no *Glyptodon*, no long-jawed mastodon, no *Elephas imperator*, no *Stegomastodon*, no large number of species of horses, no camels. If the Kansan and succeeding drifts were swept away, the early fossils would probably come into view. For when you pass the margins of the drift sheets or even before, where erosion has cut down to the the first interglacial deposits, you are likely to meet with the forms not found on the drift.

I take no account of the margins of the drift, except to note that south and west of them occur remains of a very rich fauna containing a high percentage of extinct animals, while north of them is found, usually near the surface, a much more improverished assemblage of mammals. In western Iowa have been collected from first interglacial beds *Elephas imperator*, *Stegomastodon*, *Camelops*, and species of *Equus*. If now these forms continued to exist during later stages in that region, can anybody explain why they so carefully avoided leaving any traces of themselves in any glacial or interglacial deposit east of Missouri River, while leaving abundant records of their existence west of the river?

I am also said to assume that the sequence of mammalian forms was essentially the same in Florida as in other regions of North America. I have presented reasons for adoption of this view and nobody has yet undertaken to disprove my positions in a comprehensive manner. I do not see why Florida formed a special case.

[8] *Op. cit.*, p. 568.

In arguing against this so-called assumption, Dr. Simpson states that the Florida mammals, when well known, generally prove to be of different species from those of the north and west. When his list of land mammals of Florida, existing and extinct[9] is examined it is seen that 63 species are listed in the Pleistocene; 38 of these are animals found north and west of Florida; and 25 species peculiar to Florida. This amounts to 61 per cent of the mammalian forms that are found outside of Florida and 38 per cent that belong in Florida alone. It is doubtful if the peculiar forms occurring there are more numerous than would be found in any other region where the smaller species have been collected and studied; and no doubt many of these Floridian species will hereafter be discovered elsewhere. On studying Barnum Brown's list of fossils found in Conard fissure, Arkansas, I find little difference.

It is a pleasure to find that Dr. Simpson is so closely in agreement with me on the similar composition of all the collections that have been assigned to the Aftonian stage in Florida. We disagree only on the time of the deposition of these fossils. I hold that those animals were buried there during perhaps the whole of the Aftonian and perhaps a part of the Kansan stage; Dr. Simpson argues against the probability of this.

As regards the deposit No. 3, there may be indeed extraneous fossils in it. I was led to refer it to the Kansan stages because the geologists insisted that deposition had been continuous with bed No. 2, and this bed I hold is first interglacial. In No. 3 there are certainly both extinct and yet existing species, but it is hardly fair to declare the extinct species as having been derived from No. 2 unless there is evidence of that origin. Deposition went on very slowly during the formation of this bed and apparently during the whole Pleistocene in this region.

In his paper on the fossils of the Seminole Field[10] Dr. Simpson regards it as important that the Melbourne collections contain so many species quite indistinguishable from those still living in the same region. He finds no evidence in any group of more than subspecific advance from that time to this. In this observation he again supports what I have more than once asserted, namely, that since the Aftonian stage there has occurred little or no evolution of specific forms. And I am permitted by Mr. Gerrit S. Miller, Jr., associate curator of mammals in the U. S. National Museum, to say that he has seen no evidence

[9] State Geol. Survey **20**: 251.
[10] Bull. Amer. Mus. Nat. Hist. **56**: 571. 1929.

that during the Pleistocene there has been, among the mammals, any development beyond that of subspecies. If there has occurred since early Pleistocene times the rapidity of development of new species implied by Dr. Simpson, I ask him what kinds of mammals lived during the early Pleistocene and where they have been collected? My belief is that the Melbourne fossils are those early Pleistocene mammals and that our existing species lived at that time. I might be willing to admit that some early forms may have undergone some of the minute changes which we think justify new specific names, but which other persons might not recognize as sufficient. Evolution is a slow process.

Dr. Simpson states that it has been genera rather than species that have survived. That is true, for the simple reason that a genus usually embraces more than one species and as long as one of these survives the genus continues. He also thinks that it is very exceptional that all the species of a genus in an area as large as North America should become extinct simultaneously. I do not see why this may not have sometimes happened, especially in the cases of genera including few species.

On another page, Dr. Simpson grants[11] that as high as 70 per cent of the Melbourne mammal fossils belong to extinct species. Usually such a high percentage of extinct species is accepted as an evidence of antiquity. On the next page he claims that it is no solution of the question to say that this extinction took place between the early and middle Pleistocene rather than between the late Pleistocene and the Recent. However, no one has claimed that all that 70 per cent of extinction occurred during that early stage. Not all the extinct mammals found in the Melbourne beds became extinct at that Aftonian time; comparatively few of them. The others perished at various later times, even up to the Recent. The common mastodon and *Elephas columbi* and *Castoroides* and many others of that fauna continued on until after the last glacial stage. My contention is that some of the species, as *Elephas imperator* and the few camels and the saber-tooth tiger and *Megatherium* and *Chlamytherium* died out then, for they have never been found in deposits whose later age can be demonstrated. And it would be strange surely if all those species had lived on through three or four glacial stages and then perished without any adequate explanation. Now, can Dr. Simpson or anybody else say anything against this statement?

[11] *Op. cit.*, p. 570.

But that is exactly the doctrine that Dr. Simpson is supporting: That all the species of horses found in Florida, all of the tapirs, all of the great sloths of various genera; all of the armadillos, all the elephants and mastodons; all of the capybaras, all the bisons, and all the species of several genera of peccaries; all of these lived on until in the late Pleistocene or to the Recent and then, in a time geologically brief, were swept out of existence. This is not all. There are those who apply this late existence and rather recent extinction to these genera over the whole of North America. *Elephas imperator*, and the camels are reported to have lived possibly within a few hundred years.

At this point reference may be made to Dr. Simpson's statement in his foot-note on *Bison*.[12] I am unaware who has so positively asserted that the occurrence of an extinct species of *Bison* is indicative of an early Pleistocene age.

It seems necessary to discuss again the climate of Florida during glacial stages. Dr. Simpson adheres to the idea that this state furnished an asylum where obsolescent groups survived beyond the time of those farther north. I have considered the statement that the climate of Florida has been more favorable for animal life than the northern states.[13] I have shown that the state of Illinois has harbored within historical times quite as many species of mammals as Florida; while the mountainous region of Colorado has offered an asylum to a considerably greater number than Florida.

Some of our vertebrate paleontologists appear to have evolved their theories of the glacial stages from the depths of their unaided consciousness, instead of from the writings of geologists and explorers and from personal exploration. On page 485 of Chamberlin and Salisbury's *Geology* is a fine discussion of the climatic conditions in front of a continental glacier. Further definite information can be secured from an examination of Pirsson and Schuchert's glacial map on page 945 of their *Text Book of Geology*. There it is shown, that, at some time, or at some times, during the Pleistocene, local glaciers far more extensive than those of the Recent epoch occupied the great range of the Andes, even on the equator; also in the Himalayas, and on the equator in Africa. It is evident that during a glacial stage the temperature of the whole world was lowered. It is evident, too, that in front of the continental glacier there was an arctic climate; farther away, a subarctic, a subtemperate, etc., each extending south for hundreds of

[12] *Op. cit.*, p. 569.

[13] THIS JOURNAL 19: 469. 1929.

miles. That map ought to bring conviction to even those paleontologists who were the promoters of the idea that in Iowa, during the Nebraskan or the Kansan stage, camels, elephants, ground sloths, horses, and musk-oxen lived together in the immediate front of the glacier. It has been suggested that at least these animals migrated thither during the warm summers; but on what food did they appease their appetites? Did they all alike subsist on rock-lichens and moss?

The writer does not object to the most complete investigation of the geology and paleontology of Florida; but that alone will probably not furnish a solution of the age of the Melbourne fauna. The problem is a more general one. The mammals of North America during the Pleistocene did not consist of three, or even more, distinct assemblages occupying different tracts of the continent. They were of triple origin, but they formed one faunal assemblage. This varied somewhat in composition according to temperature, moisture, kind and abundance of food, the stage of the epoch, and the like, but there were almost everywhere many genera and not a few species which ranged from the Atlantic to the Pacific, and from the Aftonian to the close of the Wisconsin. There were also subregions, occupied by peculiar genera and species, as there are today.

On the other hand, there was one wide-prevailing cause of disaster which operated at four or five times simultaneously on this whole assemblage of mammals. This was the occurrence of continental glaciations and the consequent lowering of the temperature, disturbance of weather conditions, general expatriations and repatriations of the mammalian inhabitants, and the extinction of many important genera and species.

If the glacialists are correct in their conclusions, the arctic climate was transferred at one time from its present limits to the Ohio River at Louisville, a distance of about 1,600 miles. From this border to central Florida is about 800 miles. We know that at our own day winter storms penetrate this interval and produce severe damage on vegetation and doubtless on animals also; but how much more injury and suffering and death must have been inflicted by storms starting over the ice fields at a high elevation, and sweeping as far south as Florida.

Dr. Simpson describes[14] a species to which he assigns the name *Boreostracon floridanus*. He also gives an abstract of the discovery and naming of previously collected materials which were referred to

[14] Bull. Amer. Mus. Nat. Hist. **56**: 581. 1929.

the genus *Glyptodon*, as *G. petaliferus* and *G. rivipacis;* and he ends by declaring that these names are *nomina nuda*.[15] Accordingly these species and the genus are excluded from his lists of Florida fossils. Here Dr. Simpson is mistaken. A *nomen nudum* is a name only, one without description, figure or a reference to one or all of these. Both of the names mentioned are based on type specimens which are preserved, on descriptions, and on figures, and these names must therefore be respected. I am reproached with failure to provide diagnoses as required by the nomenclatural code. On the contrary, in citing the original descriptions and figures, I did all that code requires. It may be that the fossils do not belong in the genus *Glyptodon*, but the specific name *petaliferus* for Cope's specimen and *rivipacis* for the one found in Florida must be retained. On any day some lucky collector may gather materials that will reinstate these species to their proper position. As for the other specimens found in Texas and Oklahoma, if Dr. Simpson can withdraw them from the genus and species to which I assign them, he is at liberty to do so. Otherwise they must stand until somebody can define them to his satisfaction.

In referring to the age of the fossils found by J. W. Gidley and Kirk Bryan in the San Pedro Valley, southeastern Arizona, Dr. Simpson sustains the assignment of the formations and fossils to the Pliocene. The present writer has always doubted the correctness of this action. Whether this doubt is justified or not, the deposit must be very close to the parting between the Tertiary and the Pleistocene. The presence of two or three well developed, but as yet undetermined, species of *Equus* attests to this; and I believe that the existence of any species of this genus in the Pliocene has not been demonstrated. As to the evidence on the part of geology on this point, it is improbable that any geologist can distinguish in that region, between late Pliocene deposits and those of the Nebraskan stage of the Pleistocene. Gidley details the reasons why the choice might be in favor of the Pleistocene and those why the Pliocene received the preference. The mastodons are said to be of distinctly Pliocene type; but certainly *Stegomastodon* is well known in the first interglacial stage. Also all of the species of rodents belong to existing genera and, although no existing species is recognized, several are admitted to be close to modern forms. The decisive elements in the correlation are for Gidley the presence of the genera *Hipparion, Pliohippus, Pliauchenia, Merycodus* and *Glyptotherium*. On *Hipparion* as having furnished one or more Pleistocene

[15] *Op. cit.*, p. 583.

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[15] *Op. cit.*, p. 583.

species I have given my opinion more than once, that it came up into the Pleistocene. *Pliohippus* has been referred with doubt more than once to the Pleistocene. *Merycodus*, as well as the genera *Pliohippus* and *Pliauchenia*, are fertile of species in the Pliocene and that they should continue to live in the earliest Pleistocene would not be surprising. It will be necessary for vertebrate paleontologists to recognize the existence of a Nebraskan stage of the Pleistocene, and no good reason has been presented why only a very few genera of large Pliocene animals should pass the line.

We come now to the genus *Glyptotherium*. The type of the genus was described from the Upper Pliocene formation, the Blanco. I think that no good reason can be assigned why the genus may not have continued on also into the beginning of the Pleistocene. Dr. Simpson has expressed the view that the correlation of a collection ought to be based on the more recent genera involved. In the present case it appears that he and Gidley have reversed the principle, inasmuch as they lay more weight on the Tertiary genera *Hipparion*, *Pliohippus*, *Merycodus*, *Pliauchenia* than on the on-coming genera *Equus*, *Lama*, *Odocoileus*, and the on-coming genera of rodents.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

228TH MEETING

The 228th meeting was held in the Assembly Hall of the Cosmos Club on the evening of Thursday, December 19, 1929. The meeting was the first of a series devoted to Genesis and Development, or Origin and Evolution. The purpose and plan of the series of addresses on this subject were first explained by W. J. HUMPHREYS, Chairman of the Committee on Meetings. The principal speaker of the evening, Dr. L. H. ADAMS of the Geophysical Laboratory, then gave the first of the series, entitled *The Creation of the Earth*. The Earth revolves around a sun which is merely one of many millions of stars in our galaxy, which in turn is only one of a very large number of similar galaxies, or spiral nebulae, scattered throughout space. The individual stars are in constant motion but the average distance apart is so great that not often will two stars collide or even approach near to each other. There is little doubt, however, that this rare event did happen about two thousand million years ago, the close approach of another star to the Sun being the first step in the origin of the Earth. The gravitational attraction caused tidal phenomena on a grand scale. Great protuberances were finally pulled entirely away from the Sun, and these masses after subsequent cooling to a liquid and then to a solid state became the Earth and the other planets of the solar system. During the last stages of crystallization the water of the oceans and the gases of the primitive atmosphere were evolved. Geologic history was then about to begin. (*Author's abstract.*)

229TH MEETING

The 229th meeting, being the 32d annual meeting of the Academy, was held in the auditorium of the National Museum on the evening of Tuesday, January 14, 1930. The meeting was called to order by Vice-President ADAMS. The retiring President, Dr. ALEŠ HRDLIČKA, delivered his presidential address, the subject being *Organic Evolution, its Problems and Perplexities.* This address has been published in *Science* for February 28, 1930.

At the close of the address there was a short intermission, after which the business meeting was called to order by the President.

The Recording Secretary, W. D. LAMBERT, read the minutes of the 31st annual meeting, which were ordered approved.

The Corresponding Secretary, L. B. TUCKERMAN, presented his report for the preceding year. The deaths of eighteen members were reported during the year, namely:

JAMES P. AULT
R. W. BALCOM
ERICH BECHER
EMILE BERLINER
A. W. BOSWELL
H. C. FRANKENFIELD
J. GOLDBERGER
CAREY V. HODGSON
E. LESTER JONES
D. S. LAMB
G. P. MERRILL
JOHN F. MORAN
C. W. RICHARDSON
ROBERT RIDGWAY
PHILIP S. ROY
E. E. SLOSSON
FRANCIS A. TONDORF
P. A. YODER

On January 1, 1930, the membership consisted of 15 honorary members, 3 patrons and 551 members, one of whom was a life member. The total membership was 570, of whom 363 reside in or near the District of Columbia, 173 in other parts of the continental United States, and 34 in foreign countries.

The Board of Managers held three meetings which considered, in addition to routine business, the proposed revision of the By-Laws, the proposed series of lectures on Origin and Evolution, and the policies of the Journal.

The report of the Corresponding Secretary was ordered accepted.

The annual report of the Recording Secretary was presented by him. Five public meetings were held. The names of the speakers and their subjects were given. The report was ordered accepted.

The annual report of the Treasurer, R. L. FARIS, was presented by him. Receipts during the year were $8,315.06, including $2600 of investments paid off. Total disbursements were $7,509.30, including $3000 of investment and reinvestment. The cash balance on Dec. 31, 1929, was $2,798.70, with current accounts payable estimated at $400. The value of investments of the Academy was $18,936.37, the total assets $21,882.45, and the estimated net worth $21,209.95.

The report of the Auditing Committee, consisting of Messrs. O. H. GISH, W. D. SUTCLIFFE and R. E. GIBSON, was presented by Mr. GISH. The report showed the accounts of the Treasurer to be correct and the securities on hand as stated in his report.

The reports of the Auditing Committee and the Treasurer were ordered accepted.

The report of the Board of Editors was presented by the Senior Editor, J. B. REESIDE, JR.

Volume 19 of the Journal consisted of 490 pages, a smaller number than in previous years. The cost of the Journal, including the Academy's share

of the expense of reprints, was $6.73 per page, an increase of $0.13. The volume was illustrated by 27 half-tones and 30 line cuts. The report showed the distribution of articles among the various sciences and stated that there had been no changes in policy. The report was ordered accepted.

The Corresponding Secretary presented the proposed revised By-Laws. These By-Laws were submitted at a meeting of the Academy held May 18, 1928, and have been considered by the Board of Managers and been recommended by them for adoption in amended form, as printed in the Journal for December 19, 1929.

It was moved, seconded and carried that the new By-Laws, as recommended by the Managers, be adopted, to take effect on March 1, 1930, with the understanding that all officers elected under the present By-Laws hold office until their successors are elected. It was stated that this form of motion was intended to avoid possible confusion due to changes made in the new By-Laws regarding the qualifications for holding office in the Academy.

The report of the Committee of Tellers for the Annual Election, consisting of K. S. GIBSON, W. D. LAMBERT and L. V. JUDSON, was presented by the Corresponding Secretary. In accordance with the report the following officers of the Academy for 1930 were declared elected:

President, WILLIAM BOWIE
Non-Resident Vice-Presidents, WALDEMAR LINDGREN, HARLOW SHAPLEY
Corresponding Secretary, L. B. TUCKERMAN
Recording Secretary, CHARLES THOM
Treasurer, H. G. AVERS
Managers for the term of three years ending January 1933, P. R. HEYL and G. N. COLLINS
Manager for the term of two years ending January 1932 (to fill vacancy), J. B. REESIDE, JR.
Manager for the term of one year ending January 1931 (to fill vacancy), G. R. PUTNAM

The new President was escorted to the chair by Past President HUMPHREYS. He thanked the Academy for the honor of the election.

The Corresponding Secretary reported that the following members of the Academy had been nominated by the affiliated societies for Vice-Presidents:

Archeological, Dr. WALTER HOUGH
Bacteriological, Dr. A. C. HUNTER
Electrical Engineers, Dr. M. G. LLOYD
Entomological, Dr. A. G. BÖVING
Geographic, Dr. F. V. COVILLE
Geological, Mr. S. R. CAPPS
Helminthological, Capt. C. S. BUTLER
Mechanical Engineers, Mr. H. L. WHITTEMORE
Medical, Dr. H. H. KERR
Military Engineers, Col. C. H. BIRDSEYE
Philosophical, Mr. WALTER D. LAMBERT

In accordance with a motion duly made, seconded and carried, the above nominees of the affiliated societies were declared elected Vice-Presidents.

There being no further business presented, at 9.55 P.M. the meeting adjourned.

WALTER D. LAMBERT, *Recording Secretary.*

230TH MEETING

The 230th meeting of the Academy was a joint meeting with the Geological Society, held in the Assembly Hall of the Cosmos Club on Thursday, January 30, 1930. The meeting was called to order at 8:15 P.M. by the President, Dr. WILLIAM BOWIE, who presented Dr. G. R. MANSFIELD, President of the Geological Society, as the active chairman of the meeting. Dr. MANSFIELD introduced the speaker of the evening, Mr. R. H. SARGENT of the U. S. Geological Survey, as one whose many years of personal acquaintance with the geography and topography of Alaska had made him the natural leader and adviser in the development of an air survey of that territory.

Program: R. H. SARGENT: *Photographing Alaska and its glaciers from the air* (illustrated by three reels of pictures).

The Alaskan Branch of the U. S. Geological Survey, which is entrusted with the geologic and topographic mapping of Alaska, has already completed 46 per cent of the territory. The topographic mapping has been accomplished by the regular ground methods, but within the past few years, aerial photographs as aids in mapping have come into use. The members of the Geological Survey realized their value in supplementing ground methods especially in Southeastern Alaska where the country is covered with a heavy mantle of timber and brush, the topography is rugged and irregular, and the climatic conditions are very unfavorable. Accordingly the Navy Department was requested by the Interior Department to make aerial photographs of this section of Alaska.

In 1926 the Navy Department sent an expedition under the leadership of Lieutenant Ben H. Wyatt to the Territory for this purpose. Again in 1929 a similar expedition, under the command of Lieutenant Commander A. W. Radford, was sent to continue this work. Each of these expeditions consisted of an airplane tender, a covered barge which was used as living and working quarters for the aerial and photographic sections, and four amphibian planes. The personnel included 110 officers and enlisted men.

In Southeastern Alaska there are over a dozen Federal Agencies which it was considered might be aided by these airplane photographs. In turn, these agencies have boats and other equipment which could be of aid to the Navy expedition. Accordingly a coördinated coöperative agreement was entered into by all of these Federal agencies. The results of this coöperation were most gratifying.

The mapping cameras used have 4 lenses, 3 of which are in one huge case while the 4th is in a small box attached to the rear of the main case. The A, C and D lenses are set at an angle with the B lens in order to cover more country. In making an exposure all four shutters work in unison and four pictures are made at the same instant. Because of the obliquity of the three lenses, A, C and D, the negatives of these lenses are distorted and they must be corrected by printing them in a peculiar type of printer known as a transforming printer. The transformed print is keystone shaped. The B print is joined with these keystone prints to make one large photograph.

From these pictures the cartographic data is taken by a special method. Over 13,000 of these combined photographs, covering an area of over 23,000 square miles, will be in the possession of the Geological Survey when they have been printed. As an aid to topographic mapping they are invaluable.

In addition to these mapping photographs, many excellent and valuable oblique pictures were taken over the side of the planes. These photographs

were taken as part of the coöperative scheme. They included many views of areas of timber for the Forest Service, water power for the Federal Power Commission, views along the International Boundary for the Interstate Boundary Commission, of lighthouses for the Light House Service, and mountains and glaciers for the Geological Survey. These are all of economic and scientific value.

The members of the Forest Service, which bureau is entrusted with the administrating and development of the Forest of Alaska, have found these pictures most valuable. The mapping pictures assist them in estimating and evaluating the timber of the district. The oblique photographs serve for detailed studies of particular stands of timber, mountain passes, water power, harbors and other items of economic importance.

There is no way of evaluating the worth of these expeditions but it is certain that it is great. There are concrete instances of an actual saving having been made of many thousands of dollars in addition to the scientific value of the photographs. (*Author's abstract.*)

231ST MEETING

The 231st meeting was held in the auditorium of the National Museum February 20, 1930. Dr. W. D. Lambert called the meeting to order at 8:15. Professor E. W. Berry of Johns Hopkins University gave an address entitled "The Origin and Evolution of Plants."

The speaker began by defining plants as "catchers and preservers of energy" in contrast to animals as expenders of energy. Hence, he concludes that the plants must have preceded animals. He referred briefly to the generally accepted view that the earliest forms must have been marine and delicate and that practically no record occurs to cover the very early periods, then passed to the presentation of his series of slides showing geologic remains, restorations and distribution charts. Although a few of the lower forms were mentioned, the slides were selected to show continuity throughout geologic time in the developmental series from Lepidophytes, Arthrophytes, Pteridophytes, Pteridosperms, etc., toward early and recent conifers. He concluded by showing distribution charts, both geologic and recent, for such forms as sassafras and tulip tree. Stress was put upon continuity as a dominant feature of the plant world.

232ND MEETING

The 232nd meeting of the ACADEMY was held in the auditorium of the National Museum at 8:15 P. M. on Thursday, March 20, 1930, with about 125 persons present. President BOWIE introduced Dr. PAUL S. GALTSOFF who gave the fourth address of the series upon the general subject of *Origin and evolution.*

Program: Dr. PAUL S. GALTSOFF: *Old and new concepts of the organism in the light of experimental studies on sponges.* The cellular theory of organisms advanced in 1834–35 by Schleiden and Schwan had an enormous influence on the development of biology in the 18th century because it brought under a single point of view such different biological disciplines as embryology, heredity, physiology, and evolution. According to this theory, the key to the solution of various problems of these branches of biology is looked for in the cell which is regarded both as an anatomical and physiological unit of the organism. From this point of view the organism is comparable to a colony of cells or "cell state" in which by physiological division of labor and differentiation the various cells acquired different features and specialized in perform-

ing different functions. This point of view is severely criticized by the advocates of the theory of the "organism as a whole" who regard the fact that the organisms are built of cells of secondary importance and that the "whole" dominates over its parts.

The author's experiments on regeneration of sponges from completely separated tissue cells uphold the first point of view and may shed light on the nature of living organisms. In the experiments the tissue cells of a sponge are separated by squeezing a piece of sponge through fine silk. Then the disjoined cells are placed in sea water in which they sink, begin to creep on the bottom, coalesce and form an aggregate which in about 10 days regenerate into a new sponge. The regeneration is accomplished by the process of sorting out of the cells or their rearrangement so that every cell occupies again its right place in the organism. Superficially, at least, it seems as if an outside force or "intelligence" was directing the orderly rearrangement of the destroyed individual, but the experiments prove that the behavior of the cells depends on physical and chemical properties of their protoplasm and the surrounding medium. For instance, no development takes place if the aggregates are placed on a greasy substance upon which the cells are unable to spread. It has been demonstrated also, that the development of the aggregate is due to a slow motion of the cells and that the cells of different species, when mixed together, fail to form a compound aggregate because the protoplasm of cells of two different species fails to coalesce.

Experiments on sponges uphold the "cell-state" theory of the organism since they show that the regeneration of the individual organism is brought about by the combination of individual cells; during the process there is no multiplication of cells but merely their rearrangement. (*Author's abstract.*)

233RD MEETING

The 233rd meeting of the Academy was held in the auditorium of the National Museum at 8:15, Wednesday, April 16, 1930. President William Bowie introduced Dr. Charles B. Davenport, Director of the Department of Genetics of the Carnegie Institution of Washington, who delivered an address entitled "The Mechanism of Organic Evolution." About 100 persons were present.

The mechanism of organic evolution, as I see it, consists of the following processes:—

1. Infinite capacity of the germinal material for reproduction.
2. Infinite capacity for mutation.
3. An infinitude of kinds of environments.
4. Extensive opportunities for dissemination of the mutant individuals over earth, permitting some of them to find an environment for which they are especially fitted.
5. As for the rest of the infinitude of individuals, non-mutant and mutant (beyond the number required for replacement) *elimination.*

In a sentence nature's mechanism of evolution includes the elements of: an infinitude of kinds of environments, infinite reproduction, infinite mutation, infinite opportunity for new mutants to find appropriate environments and elimination of all the infinitude of other individuals that are not required for replacement.

Homo sapiens is only a natural species with a highly evolved hand and brain. This species has reached its lofty position in evolution by the processes

described. It is proud of its control of nature in certain directions. Let it beware lest it think it can evolve further by man-made formula that may suit its perverted desires but must eventually fail of permanent progress if opposed to the formula of nature. (*Author's abstract.*)

234TH MEETING

The 234th meeting of the Academy was held in the Auditorium of the National Museum at 8:15 P.M. on Thursday, May 15, 1930. President WILLIAM BOWIE introduced the speaker, Professor MAYNARD M. METCALF of Johns Hopkins University who spoke upon the "Origin and Evolution of the Higher One-celled Animals." About 60 persons were present.

The speaker referred to the three major groups of protozoa: SARCODINA, crawling forms, which reproduce by division in any direction; FLAGELLATA, forms which swim by means of whip-like flagella, and reproduce by longitudinal splitting; CILIATA, forms which swim by hairlike cilia and reproduce by transverse division. He then discussed the origin and the evolution of the Ciliata, animals which are unique among living things in having in each cell, two nuclei, one enlarged and occupied with chemical activities, metabolism, the other unmodified and reserved for transmission of inheritance. The most primitive family of the Ciliata, the Opalinidae, are intermediate in many regards between the Flagellata and the Ciliata and show how the latter were derived from the former. Details were described which showed the change of the uninucleate Flagellata through temporarily binucleated Opalinidae into permanently binucleated higher Ciliata whose two nuclei evolved into one large metabolic nucleus and one unmodified genetic nucleus.

The adoption of a parasitic habit caused the Opalinidae rapidly to become adapted to this peculiar life, their adaptation becoming complete during a single geologic period—the Triassic. Many species have persisted almost or wholly unmodified from that time. Rapid initial modification, after adapting parasitism, and slow subsequent change are quite generally characteristic of the evolution. Such subsequent evolution as has occurred in the family has been due to factors of evolution within the organism rather than in the environment i.e. not to natural selection. This is definitely shown by the "*pattern* of *occurrence*" of the several characters of the family among the branches of the ancestral tree, which is a definitely established tree and not an hypothetical one. Orthogenesis is then more than an hypothesis, it is a fact.

The value of concomitant study of hosts and parasites in problems of geographical distribution and some of their corollaries was briefly illustrated. (*Author's abstract.*)

CHARLES THOM, *Recording Secretary.*

BIOLOGICAL SOCIETY

742ND MEETING

The 742nd meeting of the Biological Society was held in the new assembly hall of the Cosmos Club January 11, 1930, at 8.10 p. m., with President WETMORE in the chair and 65 persons present. The mintues of the preceding meeting were read and approved.

The President announced the reappointment of Dr. T. S. PALMER as Chairman of the Board of Trustees of Permanent Funds, to serve through 1930.

The President read the following resolution adopted by the Council commending the work of C. DAVIES SHERBORN:

WHEREAS, CHARLES DAVIES SHERBORN, through his bibliographical researches, has made contributions of such outstanding importance in the field of zoology,

AND WHEREAS, he has by continued and painstaking endeavor placed in the hands of his fellow workers in the "Index Animalium" an instrument of great usefulness,

AND WHEREAS, he has made other notable contributions such as a "Bibliography of the Foraminifera" and an "Index to the Genera and Species of the Foraminifera" and a "Catalogue of British Fossil Vertebrata," and other similar works,

Therefore Be it Resolved, that the Biological Society of Washington extends to CHARLES DAVIES SHERBORN its appreciation and recognition of the service he has rendered to his fellow-workers in science.

A. WETMORE stated that three hunters' skins of the giant panda had recently been received at the National Museum.

F. C. LINCOLN reported an unusual migration of waterfowl during the past autumn and winter. Ducks banded in autumn in North Dakota and Louisiana have spread east, in several cases reaching the Atlantic coast.

P. B. JOHNSON stated that in the newly born hippopotamus the hairs on the upper lip are single in the follicles, but in the adult they are in clusters.

W. H. RICH: *Alaska salmon investigations.*—The five Alaskan species of salmon all belong to the genus *Onchorynchus* and are known as the pink, chum, silver, king, and red salmon. All are anadromous and return to spawn to the same stream in which they were hatched and spent the early part of their lives. All die after the first spawning. The young stay in fresh water for varying lengths of time depending on the species and on the locality. Some migrate seaward as soon as they are able to swim, others remain in fresh water for as much as five years. The length of time spent in the ocean is also variable, from one-half to five years. Migrations in the ocean have been studied by means of experiments in which metal tags were attached to adult fish and a reward offered for the return of the tags together with data as to when and where the tags were found. Such experiments have shown that the fish caught at the end of the Alaskan Peninsula had their origin in Bristol Bay.

One of the important lines of investigation has had to do with the study in certain selected streams of the production of adult fish from known breeding populations. Weirs have been constructed across these streams and the number of spawning fish passing up the river is accurately determined. In later years the number of fish derived from the spawning of these fish can be determined. These investigations ultimately will produce information that will enable the spawning populations to be regulated so as to maintain the runs at the point of highest productivity. On the basis of knowledge of the spawning escapements as secured by weirs in some streams and by careful observations of the fish on the spawning grounds in other streams it has been possible to prophesy with considerable accuracy the size of the salmon runs for future seasons. (*Author's abstract.*)

O. E. SETTE: *Mackerel investigations (illustrated.)*—Biostatistical investigations of the mackerel fishery have been pursued by the Bureau of Fisheries since 1925, the principal object being to determine the causes for fluctuations in the catch. These fluctuations are very severe, the catch ranging from 120,000,000 pounds in some years to as low as 4,000,000 pounds in others.

From an analysis of length measurements of more than 100,000 mackerel from all American fishing localities during five years, it has been possible to determine that the rate of growth is very rapid during the first two years, an average length of 33 cm. being attained at the end of the second season. Thereafter, growth is less pronounced, eight year old mackerel being on the average about 44 cm. long. The outstanding phenomenon in the mackerel

fishery is the unequal success of various year broods surviving to commercial size. The 1923 brood furnished the bulk of mackerel in the catch for the years 1925–28. Other broods, particularly those of 1921 and 1927, furnished very few mackerel, while 1922, 1924, 1925, and 1926 accounted for almost none. In 1929, a new brood resulting from the 1928 spawning season entered the commercial catch in such numbers that for the first time since 1925, the 1923 mackerel were overshadowed by another brood.

This fully explains the extraordinary fluctuations. When a large brood enters the fishery, it furnishes good catches for a period of five years; but unless another large brood appears to augment the catch within that period, the fishery declines to very low levels.

The cause of unequal increments to the commercial fishery from year to year is excessive mortality in early stages, the critical period probably lying somewhere between the hatching of the larvae and the attainment of commercial size. In our present program, particular attention is being given to the observation of oceanographic conditions in relation to the survival of young mackerel in order that the causes of excessive mortality of young stages may be ascertained. (*Author's abstract.*)

ELMER HIGGINS: *Great Lakes investigations (illustrated)*.—The fisheries of the Great Lakes depend upon a rich and varied fauna of some 163 species of fish; half of this number are edible. The yield of the commerical fisheries for the past 50 years has been about 100,000,000 pounds annually, of which United States fishermen take 81,000,000 pounds. The yield for the past 7 years compared with the previous 7-year period has declined 16%, and many species are seriously depleted. In Lake Erie, the whitefish has declined 82%, and the cisco 94% since 1885 and 1890, respectively.

Many biological, limnological, and fisheries investigations of the Great Lakes have been conducted since 1850. Some have led to specific recommendations for regulation of the fishery, but because of divided authority of the eight States and a Canadian province over these waters, no uniform action has been taken. In the summer of 1928, the Bureau of Fisheries organized a coöperative limnological and fisheries investigation of Lake Erie, where fishery problems are most acute. State and private institutions in New York, Ohio, and Ontario coöperated, and the study was continued during 1929. Results indicate that pollution is a negligible factor in limiting the supply of fishes; that the plankton and bottom food supply is abundant; but that thermal conditions, which were carefully studied, may have direct influence upon the availability of fish. This is illustrated by the case of the cisco, which is a cold-water-loving fish, depending upon a food organism likewise limited to cold water. The configuration of the bottom together with variations in the height of the thermocline seem to have concentrated the entire stock of ciscoes in a small area in 1924, when enormous catches were made, so great, in fact, that the fishery has been practically destroyed. The commercial yield fell from 32,200,000 pounds in 1924 to 5,500,000 pounds in 1925, and remained low until the present time.

In addition to such conditions, wasteful methods of fishing appear to be an important factor in overfishing. The Bureau's investigators have therefore undertaken extensive experiments to determine the effect on the fish stock of various sizes of mesh in the nets. Experimental nets alternated with commercial nets have been operated throughout the entire fishing seasons in various parts of the lake in an effort to devise gear that is most efficient from a commercial standpoint as well as least destructive to immature fish. Defi-

nite recommendations for regulations of gear and for a more complete system of fishery statistics useful to the biologists have been offered and have been adopted by most of the States bordering the Great Lakes. (*Author's abstract*).

743D MEETING

The 743d meeting was held in the new assembly hall of the Cosmos Club January 25, 1930, at 8.10 p. m., with President WETMORE in the chair and 80 persons present. New members elected: E. A. MORAN, S. F. STANLEY.

A. A. DOOLITTLE exhibited two jars which have been hermetically sealed for five years. The jars are not absolutely tight but leak very slightly when placed in water. One was originally filled with air, one with CO_2, and in each a handful of ordinary yard soil with some nasturtium seeds was placed. A fern is now growing in each jar as well as various algae.

The regular programme was as follows:

E. N. MUNNS: *Some forestry observations in Europe (illustrated).*—The speaker described silvicultural conditions in Europe and contrasted them with conditions in this country, for the most part to the disadvantage of the latter.

P. N. MARTINDALE, ranger, Yellowstone National Park: *Intimate habits of wild animals.*—The speaker described the life of rangers in the Yellowstone National Park and gave an account of some of the larger mammals, particularly the bears.

744TH MEETING

The 744th meeting was held in the new assembly hall of the Cosmos Club February 8, 1930, at 8 p. m., with President WETMORE in the chair and 120 persons present. New members elected: HENRY O'MALLEY, J. E. SHILLINGER.

F. THONE exhibited photographs of the skull of *Sinanthropus pekinensis* and mentioned the views of several anthropologists regarding it.

P. B. JOHNSON reported, with reference to his communication on January 11, that the death of an adult hippopotamus at the Zoological Park had made possible further observations. He finds that all the hairs of each cluster of hairs on the lip and tail of the adult are united at base within the skin.

The regular program was as follows:

H. M. ALBRIGHT: *Some biological problems in National Park administration (illustrated).*—The speaker discussed some of the outstanding problems in the administration of National Parks, such as the deer problem in various parks due to overpopulation; the over-familiarity of bears in Yellowstone and Yosemite Parks, with consequent damage to property and also to tourists; the destructiveness of white pelicans to fish in Yellowstone; the predatory animal problem, which is solved by practically exterminating them in the smaller parks and leaving them almost alone in the larger parks; the overpopulation of buffalo in Yellowstone; and the protection of nesting trumpeter swans. He exhibited moving pictures of black and grizzly bears and of woodchucks, elk, and other mammals. In conclusion he introduced A. P. HARE, a former ranger, who gave an amusing account of his experiences with bears and tourists.

745TH MEETING

The 745th meeting was held in the new assembly hall of the Cosmos Club on February 22, 1930, at 8.15 p. m., with President WETMORE in the chair and 50 persons present. New member elected: M. C. JAMES.

T. S. PALMER contrasted the knowledge of biology 200 years ago and now. He also mentioned that quail have been fed by police in five precincts during the recent heavy snow, the grain being paid for by the Audubon Society. The count of the police shows 727 birds. At the time of the heavy storm in 1922 about 1200 were reported.

A. WETMORE reported that he and F. C. LINCOLN had found flocks of ducks —Oldsquaw, Goldeneye, and others—at Scotland Beach, Maryland, that day, in which the birds were evidently mated.

F. C. LINCOLN reported that E. A. MCILHENNY, in cooperation with the Biological Survey, had this winter shipped ducks captured and banded in Louisiana to various parts of the country to be released. Returns from these banded birds are expected to throw important light on their migrations.

The regular program was as follows:

A. H. WIEBE: *Some observations in increasing pond productivity.*—The object of the pond-cultural work at the Fairport (Iowa) station is to raise bass and other game fish to fingerling size for distribution. The general practice up to now has been to distribute the fish as fry. The work at Fairport is done in dirt ponds ranging in size from less than 0.1 to 3.5 acres. The water supply is pumped from the Mississippi River. The ponds are so constructed that they can be drained and all fish recovered. The young fry when 15 to 20 mm. in length are trapped and transferred to nursery ponds. This is done because bass are very cannibalistic. The production of fish is increased not by resorting to artificial feeding, but by increasing the natural food supply. This is done through the use of forage fish and fertilizers. The minnows *Notemigonus crysoleucas* (golden shiner) and *Pimephales promelas* (blackhead minnow), because of their slender bodies, their early maturity, and prolonged spawning periods, are particularly well suited for forage. The fertilizers used are sheep manure, soybean meal, shrimp bran, and superphosphate. That fertilizers have a beneficial effect is shown by the increased production of algae, microcrustacea, and fish. (*Author's abstract.*)

F. A. WARREN: *Along the trails of Mount Rainier* (*illustrated*).—The speaker, on the basis of several seasons' work, described some of the characteristic plants and animals and illustrated them by lantern slides, as well as the general features of the mountain.

C. D. MARSH: *The poisonous laurel* (*illustrated*).—Mountain laurel (*Kalmia latifolia*) and sheep laurel (*Kalmia angustifolia*) are among the most important poisonous plants of the eastern United States.

Mountain laurel was recognized as poisonous as early as 1743, and sheep laurel in 1749. One of the best descriptions of mountain laurel and its effects was published by Kalm in 1771. The first important contribution of experimental work was by Thomas in 1802. Crawford in 1908 published the only other serious contribution with experimental data. The losses of livestock have been of sheep and cattle, but it has been shown that goats, monkeys, and probably horses may be poisoned. They may also affect man. The symptoms are the same with both plants and consist mainly of salivation, pronounced nausea, irregular respiration, and weakness, which may result in complete prostration. The toxic and lethal dosage have been studied with both plants, and it has been shown that while the sheep laurel is distinctly more poisonous than the mountain laurel, animals poisoned by the sheep laurel are not as likely to die as those poisoned by the mountain laurel. Both of these plants are more poisonous to sheep and goats than to cattle. Apparently birds are not easily affected by them.

From the literature on the subject, it appears that the flesh of animals feeding upon these laurels may become poisoned. It has also been shown that when bees collect honey from these laurels, the honey becomes poisonous. Experimental work has shown quite clearly that linseed oil is effective in reducing the harmful effects of the plants. (*Author's abstract.*)

746TH MEETING

The 746th meeting was held March 8, 1930, at 8.15 p. m. in the new assembly hall of the Cosmos Club, with Vice-President JACKSON in the chair and 72 persons present. New member elected: F. C. FRIESNER.

C. W. STILES announced that the meeting of the International Zoological Congress will be held at Padua this year on September 4–11.

S. F. BLAKE mentioned the observation of about 100 gulls, apparently Herring Gulls, on the Washington Airport field that morning after a rain the night before.

The regular program was as follows:

H. S. PETERS: *External parasites of birds (illustrated).*—External parasites are commonly found on most wild birds. If we remember that they must all exist at the expense of their host it is reasonable to believe they must have a very harmful and noticeable effect on their host. This opens many interesting fields of study and raises many questions in which the bird bander, especially, should be interested. Banders may find that birds repeating very often at traps or feeding stations are parasitized, weakened and unable to seek their own food. I believe ectoparasites have a definite effect on the behavior of the birds, probably causing them to have a somewhat shorter migration route, shorter life, smaller size and duller plumage; to sing less; and perhaps to have a lower and more variable body temperature than the birds not infested.

All groups of ectoparasites are visible to the unaided eye and may be easily picked from their host with small forceps and placed in small vials of 70% alcohol for killing and preserving until being mounted on microscope slides for identification.

The biting lice or Mallophaga are most commonly observed and are found on all species of birds. They feed on parts of the feathers and scales of the skin and cause much irritation by their sharp claws. Feather mites are the most abundant parasites but are easily overlooked due to their small size. Ticks are often found on ground-frequenting birds and cause a great loss of vitality by sucking the blood of the host. The stick-tight flea is often found in masses on the head of birds, especially in southern United States. The bird flies (*Hippoboscidae*) are found principally on young birds. The ectoparasites which feed on blood probably have more harmful effect on the birds than the lice. It is hoped that bird banders will observe these parasites and their effect on the host, thus aiding the entomologist in his study of their life history, host relationships, abundance and distribution. (*Author's abstract.*)

PAUL BARTSCH: *Collecting in the Caribbean Islands (illustrated).*—The speaker gave an account of his explorations in the West Indies last summer in search of land molluscs on a Walter Rathbone Bacon Traveling Scholarship. Nearly all the large and small islands of the West Indies and off the coast of Venezuela were visited and extensive collections obtained.

747TH MEETING

The 747th meeting was held in the new assembly hall of the Cosmos Club March 22, 1930, at 8.10 p. m., with President WETMORE in the chair and 130 persons present. New member elected: C. V. MORTON.

A letter was read from C. T. REGAN thanking the Society on behalf of the Trustees of the British Museum for its resolution expressing appreciation of the bibliographical work of C. D. SHERBORN.

The regular program was as follows:

VERNON BAILEY: *Some biological problems of the Grand Canyon region (illustrated).*—The speaker spoke of a few of the many biological problems of the Grand Canyon country, with lantern slide illustrations and moving pictures of the Kaibab deer herd, the tufted-eared Abert squirrel, white-tailed Kaibab squirrel, and the porcupines. A colored slide of life zones across a section of the Grand Canyon showed the climatic barrier between the many distinct species of mammals only 13 miles apart on the two sides of the canyon.

Pictures were shown of the Supai Indians living in the bottom of Havisu Canyon in much the primitive style of the ancient cliff-dwellers of the Grand Canyon and possibly their direct descendents.

The buffalo herd in Houserock Valley, the introduced antelope herd in the Grand Canyon, the mountain sheep along the canyon walls, and the Rocky Mountain mule deer on the Kaibab Plateau were shown in colored lantern slides and their present status discussed. The present system of controlling the overabundance of mule deer by carefully supervised hunting on the edges of their winter range was highly commended and the perpetuation of this splendid deer herd considered assured through the best system of game management ever put into practice in this country. The control of predatory mammals, the mountain lions, bobcats, and coyotes, was shown to be absolutely essential to maintaining the game animals as well as the protection of livestock interests of the region. With our present knowledge of the habits of both the predatory and game animals it is now possible to regulate the abundance of any species of larger mammals as seems most desirable. (*Author's abstract.*)

E. P. KILLIP: *Over the Peruvian Andes and down the Amazon for plants (illustrated).*—An expedition was sent by the Smithsonian Institution to eastern Peru to make general botanical collections and to study especially plants used as fish poisons, the party consisting of A. C. SMITH, W. J. DENNIS, and the speaker. Brief stops were made in the mountains at Río Blanco, Tarma, Huancayo, and Huanta, but the main work was carried on in the little-known *montaña* region of eastern and northeastern Peru. This was first reached at Kimpitiriki, on the Apurimac River. After a month in the Chanchamayo Valley, the party proceeded over the Pichis trail and down the Pichis and Ucayali rivers to Iquitos, on the Amazon, in the extreme northeastern corner of the country. Several weeks were spent along the Marañon and Huallaga rivers and at Yurimaguas. The expedition then went down the Amazon to Pará, making a stop at Manáos.

Approximately 9200 numbers of plants were collected in two complete sets, for the National Museum and the New York Botanical Garden which coöperated in the project. Extra material was obtained for study by specialists in certain plant groups. (*Author's abstract.*)

748TH MEETING

The 748th meeting was held in the new assembly hall of the Cosmos Club at 8.10 p. m. on April 5, 1930, with President WETMORE in the chair and 95 persons present.

S. F. BLAKE mentioned that the grass on the large ant nests along the Maryland route to Great Falls has remained green through the winter, while the grass close by is dry and withered, and asked for an explanation from entomologists present.

A. WETMORE discussed the limits of the Washington Region as set by different writers by the subject, and favored its extension, from the ornithological point of view, to a circle 40 or even 50 miles in diameter. Discussed by V. BAILEY, who also favored its extension from the point of view of mammalogy; by C. H. MERRIAM, who showed from his own collecting experiences to what an extent the wild life of the region has been pushed back from the city within recent times; and by S. F. BLAKE, who felt that such an extension would bring in too many plants belonging to diverse associations.

The regular program was as follows:

P. G. REDINGTON: *Alaska and some of her interesting inhabitants* (*illustrated*).

749TH MEETING

The 749th regular meeting was held in the new assembly hall of the Cosmos Club April 19, 1930, at 8.10 p. m., with Vice-President STILES in the chair and 55 persons present. New member elected: W. L. BROWN.

Dr. G. W. FIELD stated that the discovery of oil in southern Louisiana, close to the large bird reservations on which migratory waterfowl congregate during the winter, has raised new problems in their protection. A bill will be brought up in Congress amending the Oil Pollution Act of 1924 by extending its provisions to the Great Lakes and navigable inland waters (as well as to coastal waters), and putting its enforcement under the officials administering the Migratory Bird Act.

Dr. L. O. HOWARD introduced Dr. DAVID MILLER, Government Entomologist of New Zealand.

The regular program was as follows:

H. L. WESTOVER: *Plant exploration in Turkestan* (*illustrated*).—The speaker gave an account of his travels through Russia and Turkestan in search of alfalfas resistant to the bacterial wilt (*Aplanobacter insidiosum*), a disease that has been very destructive in the best alfalfa growing districts of the Middle West in recent years. Arrangements for the trip were made previously with the Institute of Applied Botany at Leningrad and this Institute permitted a member of their staff to act as interpreter for the expedition. Mr. WESTOVER was accompanied by W. E. WHITEHOUSE of the office of Foreign Plant Introduction. They entered Russia at Leningrad and after visiting scientific institutions there proceeded to Moscow, Kiev, Kharkov, Saratov, Samara, and thence to Tashkent. The Soviet Government is conducting extensive experiments in agriculture at these points and is spending considerable money in the construction of laboratories and in equipping them. Nearly two months were spent in Turkestan collecting alfalfa seed from all the important seed producing districts between the Chinese Boundary and Caspian Sea. In addition, seeds of pistache, wild plums, wild apricots, legumes, grasses and melons were secured. The melons of Turkestan are noted for their wonderful flavor and great variety.

The conditions among the natives of Turkestan are very primitive. The houses are constructed of mud and usually contain little or no furniture except rugs, which serve as chairs, beds, and covering for the ground. The common plow is a crooked stick with a metal point. The crops such as alfalfa and cereals are harvested with a sickle and are usually thrashed by beating with sticks or tramping with horses. Camels furnish the chief means of transportation to the railroads. (*Author's abstract.*)

OSWALD SCHREINER: *Biological science in the East Indies* (*illustrated*).—The speaker described the organization of agricultural and medical investigations in Java as observed by himself at the recent Pan-Pacific Congress.

750TH MEETING
51ST ANNUAL MEETING

The 750th regular and 51st annual meeting was held May 3, 1930, at 8.00 p.m. in the new assembly hall of the Cosmos Club, with Vice-President JACKSON in the chair and 11 persons present. The minutes of the last annual meeting were read and approved. The reports of the Recording Secretary, Corresponding Secretary, and Treasurer were read and ordered placed on file. The election then took place, as follows:

President, A. WETMORE; *Vice-Presidents*, C. E. CHAMBLISS, H. H. T. JACKSON, C. W. STILES, T. E. SNYDER; *Recording Secretary*, S. F. BLAKE; *Corresponding Secretary*, W. H. WHITE; *Treasurer*, F. C. LINCOLN; *Members of Council*, H. C. FULLER, W. R. MAXON, A. A. DOOLITTLE, I. HOFFMAN, E. P. WALKER.

S. F. BLAKE, *Recording Secretary*.

GEOLOGICAL SOCIETY

462ND MEETING (*continued from page 243*)

J. B. MERTIE, JR.: *Mountain building in Alaska.*—Reconnaissance geologic surveys in Alaska have progressed to the point where the general character, distribution and sequence of sedimentation and vulcanism are now known. This record affords an effective means for deciphering the history of mountain building, although the mechanics of mountain making, for lack of adequate structural data, are as yet only imperfectly understood.

Orogenically, the highlands of Alaska are classified into five structural provinces:—first, the southern coastal ranges; second, the Alaska Range; third, the highland areas of central Alaska; fourth, the Kuskokwim highland, of southwestern Alaska; and fifth, the Brooks Range, of northern Alaska. Genetically, the mountains of southeastern Alaska are related to the first two groups of highlands.

By provinces, the orogenic history is summarized as follows:—

A. SOUTHERN COASTAL RANGES.

1. Progressive submergence during Lower Jurassic, accompanied by great outpourings of basic lavas.
2. Partial uplift and deformation at end of Lower Jurassic, followed by resubmergence.
3. Progressive submergence throughout Middle and Upper Jurassic, accompanied by hinge-line deformation along northern coastal margin, by granitic intrusions and by deformation of deeply buried Jurassic sediments.

4. Epeirogenic uplift at end of Jurassic and creation of highland area by differential eorsion.
5. Partial submergence in late Lower or early Upper Cretaceous, accompanied by differential deformation of adjoining land areas, and possibly by injection of granitic rocks.
6. Epeirogenic uplift in early Eocene, followed by formation of coal measures.
7. Deformation of coal measures in late Oligocene followed by long interval of erosion in Miocene.
8. Regional uplift and mountain building in Pliocene, accompanied by basic lava flows.

B. ALASKA RANGE.

1. Land mass of moderate relief from end of Triassic to some time in Lower Cretaceous.
2. Partial submergence in late Lower or early Upper Cretaceous, accompanied by differential deformation of adjoining land areas. Some granitic rocks possibly injected at this time.
3. Uplift and major mountain building in early Eocene, accompanied by formation of Cantwell formation, and by acidic, intermediate, and basic lava flows. Granitic rocks probably injected at depth.
4. Slow differential uplift in late Eocene, accompanied by deformation of Cantwell formation and deposition of coal measures.
5. Deformation of coal measures in late Oligocene, followed by long interval of erosion in Miocene.
6. Regional uplift in Pliocene, accompanied by basic lava flows, and followed by differential uplift and formation of Nenana gravels.
7. Further deformation in Quaternary.

C. CENTRAL ALASKA.

1. Land area of moderate relief from end of Triassic to beginning of the Cretaceous.
2. Submergence in Lower Cretaceous, followed by elevation and mountain building in mid-Cretaceous, and injection of granitic rocks.
3. Submergence in Upper Cretaceous, followed by epeirogenic uplift in Eocene, and formation of coal measures.
4. Late Oligocene deformation and mountain building, accompanied by injection of monzonitic intrusives.
5. Continuous erosion in Miocene and early Pliocene.
6. Epeirogenic uplift in late Pliocene.

D. KUSKOKWIM HIGHLAND.

1. Negative element from Triassic to Tertiary.
2. Regional uplift in Eocene, followed by deposition of coal measures. Mountain making in Aleutian Range.
3. Mountain building in late Oligocene, accompanied by injection of monzonitic intrusives, and a period of cinnabar metallization.
4. Continuous erosion in Miocene and early Pliocene.
5. Epeirogenic uplift in late Pliocene.

E. BROOKS RANGE.

1. Either mountain building at end of Jurassic, or
2. Hinge-line deformation during deposition of 10,000 feet of Lower Cretaceous sediments.
3. Mid-Cretaceous mountain building, accompanied by injection of granitic rocks.
4. One or two periods of Tertiary uplift and deformation.
5. Quaternary regional uplift. (*Author's abstract.*)

Discussed by Messrs. CAPPS, RUBEY and MERTIE.

463RD MEETING.

The 463rd meeting of the Society was held in the Assembly Hall of the Cosmos Club, March 26, 1930, President G. R. MANSFIELD presiding.

Regular program: N. L. BOWEN: *Impressions of the Bushveld Complex.* Discussed by Messrs. SAMPSON, BOWEN, LOVERING, and G. R. MANSFIELD.

A. C. BEVAN: *The Front Range northeast of Yellowstone Park.* Discussed by Messrs. SEARS, BEVAN, RUBEY, LOVERING, HEWETT, RESSER and WERNER.

MARCUS I. GOLDMAN: *Types of silicification in the Paleozoic of Virginia.* The talk dealt with the results of the laboratory study of a series of silicified specimens collected by Mr. CHARLES BUTTS along the contact of the Cambrian with the Ozarkian or Canadian Jonesboro limestone in Virginia. One type was a banded limonitic rock consisting of rather idiomorphic large quartz crystals cutting across the banding.[1] This rock resembles Storz's "rosewood quartzite."[2] Basal sections of these quartz crystals showed no optic figure, and the speaker suggested that this might be due to a concealed fibrous structure in them.

Another type consisted of smaller quartz crystals cutting across the structure of small yellow filamentous and spherular bodies which Dr. DAVID WHITE believes are filaments and spores of some low form of plant, the whole rock having many resemblances to oil shales. Another type, very vesicular, gray, containing much reddish ferruginous material, is believed to be silicified rock underlying the contact. Some of its characters suggest the possibility of its formation from a gel.

A fourth type, which has the appearance of a slightly pinkish quartzite, shows under the microscope a very irregular interlocking mosaic of quartz crystals with undulatory extinction. This is believed to be a silicified calcareous rock from directly below the contact.

The character of the quartz in the second and third types was discussed. The crystals show straight, parallel lines of growth making angles with each other suggesting crystal structure, and many of them have a brush-like radiating extinction, especially in their outer parts. The difficulty of explaining the growth lines by formation from a colloid was pointed out.

The second type with plant-like bodies was interpreted as a bog iron deposit formed on a flat, relatively undrained surface between Cambrian and Ozarkian or Canadian; the other types as the result of the accumulation of iron and silica on or below this old surface. (*Author's abstract.*)

Discussed by Messrs. BUTTS, WHITE, FERGUSON, GOLDMAN, FOSHAG, TUNELL and BURCHARD.

C. H. DANE, *Secretary*

[1] Cf. Oder, Amer. Mineralogist, **14**: 382, 1929.

[2] Storz, Sekundäre authigene Kieselsäure, etc. Borntraeger, 1928, p. 91.

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